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REDUCING VOC EMISSIONS FROM SOLVENTS IN EUROPE: THE POTENTIAL ROLE OF ECONOMIC INSTRUMENTS



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This paper considers the feasibility of harmonized use of economic instruments in environmental policy in the EU and Central and Eastern European Countries (CEECs). It is argued that the effectiveness of economic instruments in CEECs (which are already well developed in some of these countries) may be affected by the economic problems accompanying the transition process, by incomplete market reform in some countries and industries, by inefficiencies in public spending and by pre-existing market distortions. The paper then focuses specifically on the example of a possible tax on solvents to reduce VOC emissions. A brief summary is given of the solvent – VOC policy issues and of the possible role of economic instruments. The potential environmental and economic impacts of a tax on solvents are considered, with special

attention for three industries (paint, printing and pharmaceuticals). The article concludes that in the present situation a differentiated tax (with lower rates in CEECs than in the EU) would be preferable to a uniform tax throughout Europe. Furthermore, the tax revenues should (at least in the CEECs) be used to support investments in (VOC) pollution abatement. © 1998 John Wiley & Sons, Ltd and ERP Environment.

INTRODUCTION

The interest in the possible advantages of using economic instruments to improve the effectiveness and efficiency of environmental policy is growing, both in the European Union and in the Central and Eastern European Countries (CEECs). The need for structural reforms seems to create a unique opportunity to incorporate 'ecological' elements into their fiscal systems. Given this Europe-wide interest in applying economic instruments, as well as the interest of some CEECs in adapting their environmental policy to that of the EU, it seems obvious to look for possibilities of a harmonized introduction of environmental taxes throughout Europe.

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One possible application area for a common economic instrument might be the use of solvents, which cause emissions of volatile organic compounds (VOCs). VOCs, together with NO_x , are chemical precursors to ozone. Policies that aim at controlling ozone air quality (e.g. the EU's acidification strategy) include measures to reduce VOC emissions. A possible tax on solvents to reduce VOC emissions has been studied for the European Commission (Olsthoorn *et al.*, 1996). There are several complicating issues which need to be addressed before such an instrument could be applied in practice. Some of them relate to the particular circumstances prevailing in the CEECs and the specific role which environmental taxes play in these countries. Other issues are related to the nature of the VOC problem, which poses a complex environmental policy problem.

The aim of this article is to assess the feasibility of introducing harmonized environmental taxes in Europe, based on the example of a tax on solvents, in both the EU and CEECs. The first section discusses the particular role which economic instruments play in CEECs, and the special circumstances prevailing in these countries which should be taken into account when introducing new economic instruments. The second section gives a brief summary of the solvent–VOC policy issues and the possible role of economic instruments. The third section sketches the main features of a possible solvent tax, whereas in the fourth section the effectiveness and economic impacts are considered, with special attention for three industries (paint, printing and pharmaceuticals). The final section presents conclusions and assesses the chances for implementation of a solvent tax in Europe.

ECONOMIC INSTRUMENTS IN CENTRAL AND EASTERN EUROPE

Institutional and legal 'harmonization' (uniformization) in the countries of the former Soviet block was prevailing in the field of environmental regulation. Basic government authorities as environment ministries and inspectorates were set up during the 1960s and 1970s, and basic environmental legislation was carried out across the countries of the region we now call Central and Eastern Europe. Following the prevailing Western trends, command-and-control type regulatory regimes were established with the key

elements of emission/performance standards and corresponding non-compliance fines. Nevertheless, the machinery of environmental regulation, while looking similar, served somewhat different goals and functioned in a somewhat different way from its Western prototype. One of the major differences is correctly described by Klarer (1994):

The concept of the rule of law as a social norm is not as firmly established in the society as it is in most Western democracies. To some extent there remains from the previous political system a rather casual regard of law as something which should look good on paper [catch up with the West] but not necessarily firmly anchored in practice (p 24).

Behavioral rules, norms and possibilities were mostly formed in informal ways and had little to do with legal norms. To learn how to create and enforce legislation that also pays attention to the interests of the regulated is a task still to be learned in many of the countries in the region. The construction of the Eastern regulatory system was also cheaper – the installation of some 'luxury' items, such as expensive monitoring instruments or environmental data gathering, were often omitted. All the above mentioned factors add up to the often reported enforcement problems in the CEECs.

In the period of liberalization of their economies, the CEE countries face the problem of how to address their environmental problems. Traditionally, the advice from the side of economists for these countries is to use economic incentives (EIs) more extensively (see, for example, Barde, 1994; Environmental Action Programme for CEE, 1993; Toman, 1994), thus substituting for the prevailing command-and-control approach and encouraging cost-effective environmental policy-making.

Indeed, we can find a variety of cases where new economic instruments have been introduced in the CEECs. Russia introduced an extensive pollution fee system in 1991 (Golub and Strukova, 1994). Similar systems have been adopted in Estonia (Klarer, 1994) and Lithuania (Semeniene *et al.*, 1996). While Poland had a system of standards and emission charges for many years prior to 1989, the role of economic instruments, especially that of emission fees, has become more important since 1990. The exceptionally high level of emission fees on SO_2 , NO_x and particulate matter emissions, and the activity



of environmental protection funds financed mostly from these revenues, reflect this kind of development (Toman *et al.*, 1994; Francis, 1994; Zyllicz and Spyрка, 1994). Existing environmental regulation in Hungary does not apply emission charges at present, although a proposal to introduce them for major air and water pollutants has been prepared recently. The use of various product charges is unique to this country (Lehoczki and Morris, 1995). A recent piece of legislation also created a system of emission fees in the Czech Republic (Sejak, 1995).

Evidence on the practical experiences with the application of economic instruments in CEECs is still scarce. The different context of their applications also makes it difficult to draw generalized statements about the experiences with economic incentives in the region. However, some cautious observations might help in defining conditions that might significantly affect the operation of economic instruments (EIs) in CEECs.

First, the so-called transformational recession hit, in a severe way, all the CEECs in the period 1989–1992.* Creeping inflation in some countries poses another problem with regard to the application of some EIs (especially charges, fines and taxes) in the region. Since such charges take mostly the form of unit taxes/charges defined on the base of units of pollutants/products, it is hard to preserve the real value of these charges in times of high inflation. Clearly, quantity-based regulations (e.g. permit markets) or *ad valorem* charges/taxes could more easily circumvent these problems.

Second, private ownership of enterprises, with a simultaneous elimination of widespread subsidization, is a necessary precondition for the meaningful implementation of EIs. However, the speed and method of privatization differ to a great extent in the region. While, as a consequence of massive privatization of state-owned enterprises, the preconditions for the application of market-based regulations have improved substantially in CEE countries such as Poland or Hungary during 1990–97, some other countries followed a much more cautious privatization policy (Brada, 1996). One should not expect the potential incentive effect of the EIs to work when they are applied in economies where the survival of enterprises does not depend crucially on their profitability.

Third, we would argue that, in the CEECs, environmental tax proposals should be put for-

ward by paying considerably more attention to the public administration and efficient spending issues than has been typical to date.† When looking at the institutional conditions that characterize environmental administration in the CEECs, one might doubt that public spending is typically efficient even in a weak sense, namely, that it finances projects with positive economic (including environmental) benefits. Cost effectiveness and cost-benefit analyses are not included in the process of public project appraisals in these countries. Wasteful spending can, through creating unnecessary distortions, induce significant additional welfare costs for these societies, thus making environmental tax proposals less appealing than they might appear at first sight.

Finally, there are some serious pre-existing distortions with respect to the operation of environmental taxes in the CEECs. The basic argument in favour of environmental taxes is based on partial equilibrium analysis (see Baumol and Oates, 1988, pp 211–234). According to the traditional view, such taxes are the rare ones that do not impose efficiency losses on the economy. Moreover, the so-called ‘double dividend’ argument claims that beyond the welfare gains caused by the correction of a negative externality, the revenue raised by environmental taxes could be used for lowering the level of already existing distortionary taxes in the economy (preferably on labour). Some recent articles (Parry, 1995; Goulder, 1995) point out that in a ‘more general’ equilibrium analysis, the imposition of the environmental tax will worsen pre-existing market distortions. This in turn will add a welfare loss to the welfare gains emphasized by the double dividend argument. This might turn out to be especially important in the CEE context, since central redistribution of incomes was historically high in these countries.

EUROPEAN POLICIES ON VOCs AND SOLVENTS AND THE ROLE OF ECONOMIC INSTRUMENTS

According to the Stockholm Declaration on the Environment (1972) the states are responsible for not polluting the environment of other states. On the basis of this principle in 1979 the European countries, USA and Canada accepted

*Concerning the analytics of output decline in CEECs see Holzmann *et al.* (1995).

†The typical institutions for environmental fund redistribution in the CEE region are Environmental Funds. For more information on the operations of these institutions see Lehoczki and Peszko (1994).



the UN – ECE Convention on Long-range Transboundary Air Pollution, within which several protocols were signed. In 1991 the UN – ECE protocol for the control of VOC emissions was signed, where participating countries (including the EU) agreed to reduce emissions by 30% by the year 1999, with 1988 levels usually as the baseline.

Emissions of VOCs contribute to the creation of ground ozone, which can damage the health of people and ecosystems. VOC emissions are a priority issue for European Commission's environmental policy. In the EC's Fifth Environmental Action Programme, the emission reduction targets for VOCs are 10% in 1996 and 30% in 2000, with respect to the 1990 levels (European Commission, 1992).

Some countries have set more stringent targets. For instance, Austria has established a reduction target of 70% by 2006 and Sweden aims at a 50% reduction by 2000, both based on 1988 levels. A number of countries have set reduction targets for individual sectors of industry. The Dutch KWS 2000 control strategy, which aims at a reduction of 63% in VOC emissions over the period 1981–2000, has provided a model which has subsequently been adopted by other countries such as Denmark and Hungary. The Dutch system specifies general measures to be taken to reduce emissions, but allowing much flexibility. In Denmark, government and industry have agreed on a 50% reduction of VOC emissions by the year 2000, with reduction targets varying by industry.

Solvent use in Europe accounts for about 50% of total (non-methane) VOC emissions from stationary sources. The EC has drafted a proposal for a directive on the limitation of emissions of organic compounds due to the use of organic solvents in certain processes and industrial installations. It requires the application of the best available technologies (BATs) and the preparation of 'solvent management plans' for several activities such as printing, surface and dry cleaning and coating processes. Sources such as small scale trade and industry, artisans and private households, are not covered by the directive. For these target groups a product-oriented approach, based on ecolabels, product standards or product charges or taxes, for instance, seems more suitable (Olsthoorn *et al.*, 1996).

The different European countries have individually adopted many different policy instruments for the control of VOC emissions, based mainly on command-and-control approaches such

as air quality and emission standards, product bans, product standards and imposition of abatement measures. Voluntary and information instruments such as voluntary agreements and ecolabels are also used.

The use of economic instruments for the control of VOC emissions is still mostly in a study stage. France, Poland and the Czech and Slovak Republics have already included VOC emissions in the list of atmospheric pollutants to which emission charges are applied. Besides, the Czech Republic stimulates the usage of water-based paints, applying to them the lower rate of VAT (5% instead of the general rate of 22%). Austria, The Netherlands and Switzerland have developed studies on the application of VOC charges and taxes, but they have not yet been implemented.* The application of other types of economic instrument such as tradable permits and 'solvent renting systems' has also been discussed in Germany.

A PRODUCT TAX ON SOLVENTS

The large variety in solvent applications and associated costs of substitution and VOC emission abatement makes the use of economic instruments particularly attractive for the control of VOC emissions from solvents. An outright ban on the production and use of solvent – VOCs is neither necessary nor feasible; limiting their application areas to the 'essential' ones would involve substantial bureaucratic effort and opportunities for fraud, and evidence in several countries shows also that the reductions of VOC emissions which can be achieved by means of voluntary measures are insufficient.

It seems clear that the most suitable economic instrument is a tax (fee, charge), given the important role of economic instruments in CEECs in raising revenue, particularly for the 'environmental funds'. Given the 'non-point' character of a large part of solvent – VOC emissions, it is obvious that an emission tax is not feasible. Monitoring emissions from all solvent users would be prohibitively expensive. Therefore, the tax should be levied as a product tax on the solvents themselves or on products containing solvents. The harmonized introduction of an environmental charge could prevent the undue deterioration of competitiveness of the regulated industries in those countries applying the charge. Also, a co-ordinated measure would prevent the incidence of

*The Swiss proposal for a tax on VOCs has been approved by parliament, but the actual status of implementation is unclear.



'environmental capital flight' induced by differences in regulatory strictness among European nations.

The proposed product tax could be uniform for all solvents, or differentiated according to the solvent category. A uniform tax is administratively simple, although it does not take the specific environmental properties of each substance into account. Certainly, the implementation of a uniform tax would put highly diverse policy-related costs on different countries, thus leaving much space for bargaining about cost sharing and room for strategic behaviour from the side of the affected country.

Another possible differentiation would be a geographical and temporal one. Although this would do justice to the possible differences in environmental impact, such a differentiation will not be feasible, because one cannot predict where and when a certain amount of solvent, which is subject to the tax, will lead to VOC emissions. Even a differentiation between member states of the EU would probably turn out not to be workable, because it could easily be frustrated by cross-border shipments. For the EU, a practical solution could be a harmonized minimum tax level, comparable with the present system of excise taxes.

The needed level of the tax rate will be determined by the emission reduction target and the price elasticity of the demand for solvents. Unfortunately, little is known about the abatement cost function for VOC emissions from solvents, which depend very much on specific circumstances, such as the type of solvent-using activity, the scale of the process and the skills of the people working with the solvents. Estimates of abatement costs for various applications range between 0 and 10 ECU per kilogram VOC reduced (OECD, 1990; Zierock, 1991). However, the amounts of VOCs which can be reduced against a given cost per kilogram are largely unknown, implying that the 'correct' level of the tax will therefore have to be found by means of 'trial and error'. Previous studies (Bruhin *et al.*, 1989; LMO, 1990; USEPA, 1991; Swedish Environmental Charge Commission, 1990) suggest a tax rate somewhere between 0.5 and 3 ECU per kg for 'ordinary' VOCs, and between 1 and 6 ECU per kg for chlorinated (and carcinogenic) VOCs, allowing emission reductions in the order of magnitude of 30 to 60%. Instead of using a nominal rate, an *ad valorem* tax (of the order of magnitude of 100%) could be imposed. The tax could be phased in gradually, starting at a low rate and increasing to its final level over a period

of say 10 to 15 years. The environmental effectiveness of the solvent tax will be enhanced if it is related as closely as possible to the amount of VOCs actually emitted, and, therefore, it would be preferable to levy the tax from the final user of the (product containing) solvent. However, the number of solvent users is too large to make this a feasible option.

An alternative is to levy the tax at the moment when the (products containing) solvents are being sold by the producers or importers. This alternative has the advantage that the number of tax payers is fairly small, thus restricting the administrative and enforcement costs. A disadvantage of this system would be its lack of compliance with the 'destination principle' and the fact that the tax burden is also put on solvents which will not lead to VOC emissions (for instance, because they are being used as a feedstock or as a fuel).

The solvent tax rules should allow for some exemptions, namely for exports of (products containing) solvents (since the tax is applied to attain local objectives and domestic producers should not be put in a disadvantageous competitive position with regard to foreign producers), for non-solvent uses of the substances and for recycled solvents (to stimulate recycling).

No exemptions should be made for those (applications of) solvents for which no reasonable alternatives are presently available. This would also take away the incentive to search for alternatives, and be administratively complex and susceptible to fraud. One of the big advantages of a tax over a ban is the fact that the market will determine where solvents are really indispensable.

A tax refund can be considered for cases where the user can demonstrate that effective measures have been taken to prevent the solvent from leading to air emissions. In the case of recycling or reprocessing, a tax refund should not be given, because the proposed system already envisages a tax exemption for recycled solvents. As long as the solvent has not been destroyed, it has the potential to produce VOC emissions and should therefore bear the tax.

Whereas the presently existing environmental levies have generally been introduced to finance specific purposes (such as the Environmental Funds in CEECs), the proposed tax on solvents is meant to be a 'pure' incentive tax and its revenues can be seen as a side-effect. Therefore, there is no reason *a priori* to allocate this money to environmental funds. Earmarking for environmental purposes could nevertheless lead to greater political and public support for the tax and contribute to



Table 1. GDP in selected countries (1990, 1991) in comparison with solvent emissions and possible tax revenue

Country	GDP (bln USD)	Solvent emissions in tonnes 1990	Revenue in mln ECU		Revenue in % of GDP mln USD
Czech Rep.	25.3	93 023	93	120	0.47
Slovakia	10.2	55 112	55	71	0.69
Poland	75.3	230 080	230	297	0.39
Latvia	4.9	1 310	1	1.3	0.03
Lithuania	5.1	11 205	11	14	0.23
Estonia	4.3	6 681	7	7.7	0.18
Germany*	1789.3	1 030 210	1030	1329	0.07
France	1278.7	635 629	635	819	0.06
Netherlands	312.3	145 249	145	187	0.05

*Only former Western Germany.

Source: World Bank, OECD, Eurostat, CORINAIR.

increase the rate of reduction of VOC emissions and lower (cumulative) costs for firms, if revenues are used to finance solvent reduction options (R&D projects, subsidies for investment in abatement techniques or low-solvent alternatives). In the CEECs, a strong case could be made for leaving at least part of the tax revenues with the taxpaying firms (on the condition that they invest in pollution abatement measures).

In the proposed tax system, all solvents and products containing solvents are treated in an equal manner, irrespective of their origin (imported or produced domestically) and therefore the tax will not come into conflict with the relevant GATT/WTO rules. The taxation of imported products will imply that their solvent content should be indicated on the product itself, or in an accompanying document, but this requirement must not be regarded as a technical barrier to trade, since it seems clear that it has no protectionist intention at all, and therefore does not offend against the GATT Standards Code.

On the other hand, the solvent tax could create an incentive for some firms to transfer their solvent-based activities (e.g., metal degreasing) to countries where such a tax is not applied. This is one of the reasons for international harmonization of the tax.

ECONOMIC IMPACT OF A SOLVENT TAX

Assuming a (uniform) tax rate of 1 ECU per kg on all solvents, introduced at once, the initial (poten-

tial) revenue in ECUs would be equal to the amount of solvents in kilograms sold in each country. If we assume that the tax is reimbursed for implemented emission reductions, and if we leave aside international trade, the potential revenues (in ECUs) are equal to the VOC emissions (in kilograms) from solvents per country. Table 1 gives an idea of the possible revenues in relation to their GDP for nine selected countries. We can see that in the CEECs the impact of a 1 ECU tax on solvents (as a percentage of GDP) is several times higher than in Western European countries. A lower tax rate in CEECs, or an *ad valorem* tax, would lead to smaller differences in tax revenue relative to GDP.

Given the large variety in applications, abatement and substitution options and cost structures, a full assessment of the economic consequences of a VOC tax for all sectors is obviously not feasible in the scope of this article. We will therefore focus on the results for three industries (paint, printing and pharmaceuticals).

In the *paint industry*, whose products are a major source of VOC emissions, even a relatively low tax rate could have a strong impact in terms of substitution by low-solvent alternatives. Nevertheless, the application of a uniform solvent tax, in ECU, will imply different impacts in the domestic markets, due to the following factors: the average price per kilogram of solvent (in ECUs) has significant differences: in CEECs it is only around 50% of the value for EU countries (this point is related to the disparities between currencies, exchange rates and the parity of purchase power); the solvent intensity in paint



production also has significant differences among CEECs and EU countries.

The available technologies to reduce VOC emissions in the *printing industry* differ according to the printing technique, and, therefore, the costs of emission abatement and of low-solvent substitutes differ widely. Solvent consumption includes not only the 'direct' incorporation of solvents in the process (e.g. as an additive) and in the cleaning operations, but also the 'indirect' incorporation through the consumption of inks. The share of solvents in the production costs will usually not exceed 1%.

In many cases, the barriers for VOC reduction are probably technical rather than financial. Even with a tax of 1 ECU per kg the share of solvent costs in total production costs would not change dramatically. The only exception is rotogravure printing, but there the recycling of toluene is often already profitable at present prices. However, given the fact that the costs of some abatement and substitution options are lower than 1 ECU per kilogram VOC abated, the tax is likely to have at least some impact on emission reductions.

In the *pharmaceutical industry*, technological substitution is not generally a feasible measure for VOC emissions reduction. The main VOC control measures taken by this industry are directed to reduce the volume of unrecovered solvents and to end-of-pipe measures. Abatement costs are usually higher than 1 ECU per kg, so a tax would need to be very high to have an incentive effect. The share of solvent costs in total production costs for this industry is almost negligible.

It can be expected that a solvent tax of 1 ECU per kg will not be a sufficient incentive for a change in the behaviour of market agents due to the restrictions to technological substitution and the high costs of end-of-pipe VOC control measures usually adopted in this sector, associated with the low impact of the tax in production costs. Command-and-control approaches, or a mixed approach, seem to be more adequate to control emissions in this industry.

CONCLUSIONS AND PERSPECTIVE

Despite their theoretical advantages, economic instruments are nowhere the core tool of environmental policy. The policy objective of reducing VOC emissions, shared by most European countries, seems to offer an interesting opportunity for the introduction of a harmonized

environmental tax in CEEC and EU countries. However, such an initiative should take into account the differences between these countries and the specific conditions prevailing in CEECs.

A tax on solvents is likely to contribute significantly to VOC reduction, without major economic harm for the industries concerned. If the tax is levied from producers and importers, and the number of exemptions is limited, implementation will be relatively straightforward. The institutional requirements of such a tax will probably not be more complicated than those of most existing excise taxes or environmental policy instruments.

A uniform solvent tax with a single rate (e.g. 1 ECU per kg) throughout Europe would be neither optimal nor feasible. In the CEECs, the tax should have a lower rate than in the EU, and the revenues should at least partly be used to assist firms in VOC reduction and solvent substitution.

A nationally differentiated approach seems to be the most realistic prospect. Several countries are already preparing concrete plans for putting economic instruments at work to reduce VOC emissions from solvents. The experiences from a variety of national initiatives might in due course lead other countries to follow suit and to some form of (partial) 'bottom up' harmonization.

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REFERENCES

- Barde, J.P. (1994) *Economic Instruments in Environmental Policy: Lessons from the OECD Experience and their Relevance to Developing Economies*, OECD Development Centre Technical Paper 92.
- Baumol, W.J. and Oates, W.E. (1988) *The Theory of Environmental Policy*, Cambridge University Press, Cambridge.
- Brada, J.C. (1996) Privatization is transition – or is it?, *Journal of Economic Perspectives*, **10**, (67–86).
- Bruhin, A., Wurm, S., Kaltenbach, J. and Meckel, H. (1989) *Entscheidungselemente für eine Lenkungsabgabe auf flüchtige Kohlenwasserstoffe*. Expertenbericht Vol. 2, Basel.
- Environmental Action Programme for Central and Eastern Europe (CEE) (1993) Document submitted to the Ministerial Conference, Lucerne.
- European Commission (1992) *Fifth Action Programme on the Environment: Towards Sustainability* COM(92)23.
- Francis, P. (ed.) (1994) *National Environmental Protection Funds in Central and Eastern Europe*, Regional Environmental Centre for Central and Eastern Europe, Budapest.



- Golub, A. and Strukova, E. (1994) Application of a pollution fee system in Russia, in: Klaassen, G. and Forsund, F.R. (eds), *Economic Instruments for Air Pollution Control*, IIASA – Kluwer, Dordrecht, pp 165–84.
- Goulder, L.H. (1995) Effects of carbon taxation in an economy with prior tax distortions: an intertemporal general equilibrium analysis, *Journal of Environmental Economics and Management*, **29**, (271–297).
- Holzmann, R., Gács, J. and Winckler, G. (eds) (1995) *Output Decline in Eastern Europe*, Kluwer, Boston.
- Klarer, J. (ed.) (1994) *Use of Economic Instruments in Environmental Policy in Central and Eastern Europe*, Regional Environmental Centre for Central and Eastern Europe, Budapest.
- Lehoczki, Zs. and Morris, G. (1995) *Possibilities For a Better Integration of Fiscal and Environmental Policies in Hungary*, Harvard Institute for International Development Hungary Environmental Economics Policy Program, Ministry of Finance, Budapest.
- Lehoczki, Zs. and Peszko, G. (1994) *Environmental Funds in the Transition to a Market Economy*, paper presented at the OECD Workshop on Environmental Funds in the Transition to a Market Economy, Budapest.
- LMO (1990) *Financiële Instrumenten voor het Nederlandse Milieubeleid*, Landelijk Milieu Overleg, Utrecht.
- Organisation for Economic Co-operation and Development (OECD) (1990) *Control Strategies for Photochemical Oxidants across Europe*, OECD, Paris.
- Olsthoorn, A.A., Oosterhuis, F.H. and van der Woerd, K.F. (1996) *Feasibility Study on the Implementation of Economic Measures to Reduce Emissions of Organic Solvents*, Office for Official Publications of the European Communities, Luxembourg.
- Parry, I.W.H. (1995) Pollution taxes and revenue recycling, *Journal of Environmental Economics and Management*, **29**, (S64 – S77).
- Sejak, J. (1995) *Static and Dynamic Efficiency Advantages of Economic Instruments*, mimeo, Prague Ecological Institute.
- Semeniene, D., Bluffstone, R. and Cekanavicius, L. (1996) *The Lithuanian Pollution Charge System: Evaluation and Prospects for the Future*, Harvard Institute for International Development Lithuania Environmental Economics and Policy Program, Vilnius.
- Swedish Environmental Charge Commission (1990) *Summary of Proposals*. SOU 1990:59.
- Toman, M. (ed.) (1994) *Pollution Abatement Strategies in Central and Eastern Europe*, Resources for the Future, Washington DC.
- Toman, M., Cofalla, J. and Bates, R. (1994) Alternative standards and instruments for air pollution control in Poland, *Environmental and Resource Economics*, **4**, (401–417).
- United States Environmental Protection Agency (USEPA) (1991) *Economic Incentives. Options for Environmental Protection*, USEPA, Office of Policy, Planning and Evaluation (PM-220), Washington, DC.
- World Bank (1995) *Hungary. Structural Reforms for Sustainable Growth*, Report 13577-HU.
- Zierock, K.-H. (1991) *Common Work Programme on the Community Strategy to Reduce Photochemical Pollution*, phase II final report, EnviCon, 1991.
- Zylicz, T. and Spycka, J. (1994) Poland, in: Klarer, J. (ed.), *Use of Economic Instruments in Environmental Policy in Central and Eastern Europe*, Regional Environmental Centre for Central and Eastern Europe, Budapest, pp 93–122.

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